



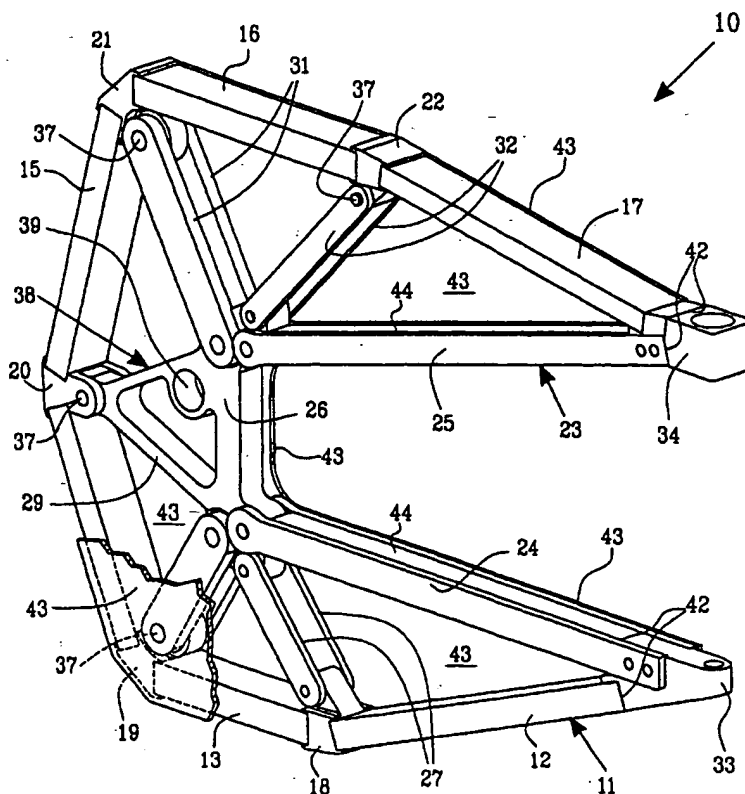
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent-Classification <sup>6</sup> : <b>B23Q 1/25</b>		A1	(11) International Publication Number: <b>WO 00/02701</b>
			(43) International Publication Date: 20 January 2000 (20.01.00)
(21) International Application Number: PCT/SE99/01106		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 18 June 1999 (18.06.99)			
(30) Priority Data: 9802192-6 18 June 1998 (18.06.98) SE			
(71) Applicant (for all designated States except US): FLEXPROP PRODUCTION AB [SE/SE]; Pilefeltsgatan 97, S-302 50 Halmstad (SE).			
(71)(72) Applicant and Inventor: HOLM, Dan [SE/SE]; Bergvägen 16 A, S-135 50 Tyresö (SE).			
(72) Inventors; and			
(75) Inventors/Applicants (for US only): STRÖMBERG, Karl-Otto [SE/SE]; Kilgränd 4, S-302 40 Halmstad (SE). HELLMAN, Hans [SE/SE]; Kyrkängsbacken 8, S-141 35 Huddinge (SE). FRÖBERG, Peter [SE/SE]; Vintervägen 26, S-171 34 Solna (SE).			
(74) Agent: GÖTEBORGS PATENTBYRÅ DAHLS AB; Sjöporten 4, S-417 64 Göteborg (SE).			
		Published With international search report. In English translation (filed in Swedish).	

(54) Title: TOOL HOLDER

## (57) Abstract

Device at tool holder (10) of the kind comprising an essentially C-shaped frame preferably having a long inner range, which frame at its free shank ends carries said tool, for instance a riveting, a glueing or a welding unit. The holder (10) comprises a truss or frame work, which includes an outer and an inner C-shaped frame (11; 23) and a number of slewing brackets (27-32) connected to these. The frames (11, 23) and the slewing brackets (27-32) are arranged to form a number of connected triangular sections, which connection points (18-22, 37) are designed as intersections or joints. The outer C-shaped frame (11) is arranged only to support thrust forces and the inner frame (23) thrust and tensile forces and the slewing brackets (27-32) substantially tensile forces.



*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav	TM	Turkmenistan
BF	Burkina Faso	GR	Greece		Republic of Macedonia	TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's	NZ	New Zealand		
CM	Cameroon		Republic of Korea	PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

## TOOL HOLDER

The present invention relates to a device in tool holders and of the kind which comprises a C-shaped frame, has a preferably long inner range, which frame at its free shank ends carries said tool, for example a riveting, a glueing or a welding unit.

### The background of the invention and the problem

C-shaped frames of the above mentioned kind are previously known and are used for joining of for instance car body components, frame works, train cars, air crafts, etc. They are made as I-shaped sections in high tensile steel since high requirements are put on the stiffness and the structural strength of the frame. Particularly when working operations, such as e.g. riveting, is in question, large opening forces arise on the shanks of the C-shaped frame. The frame is also to be exposed to a large number of working cycles and a minimum of 2 millions cycles is a demand. The C-frame must be able to operate on deeply situated parts in certain situations i.e., be able to reach a working area which is situated e.g. 1 metre inside an outer limitation. At large scale production as in the automotive industry the C-shaped too holder is being handled by a robot, which means that the weight of the C-frame should be so low that the total weight of the system is less than the allowed operation weight of the robot. At manual operation it is also desired to minimize the mass of the system.

Using the robots of today, one has reached and in some cases also exceeded the weight limit, but the market demands both larger and more stable tool holders with maintained or even lowered weight. The investments in robots are so high that it must be possible to use existing ones even for new and more extensive working operations.

Tests have been made to produce C-shaped frames from composite materials as solid models but the load strains in the intersections in the form, i.a., of shear and tear stresses in the glue joints will become so high, that these tests could not be performed. A typical steel C-frame, having an inner depth of 850 mm, a gap between the ends of the shanks of 400 mm and a calculated load in the form of opposed directed forces of 53 kN, has a weight of about 150 kg at a maximal

permitted deflection of 7 mm between the ends of the shanks. This weight together with the weight of the necessary tool equipment exceed the carrying and operating capability of the robot and are therefore not acceptable.

## 5 The object of the invention and the solution of the problem

The object of the invention is to provide a tool holder, which:

- a. has a low weight,
- b. has a high stiffness,
- 10 c. has a high strength,
- d. has a simple construction,
- e. is price-worthy,
- f. can easily be varied in shape and form,
- g. can operate in difficult environments, e.g., welding sputters,
- 15 h. has a long service life and high reliability.

These tasks have been solved by the features defined in the claims.

## Description of the drawings

20

The invention will be closer described below as an embodiment with reference to the enclosed drawings.

Fig. 1 shows in perspective a tool holder according to the invention with one front covering plate removed.

25

Figs. 2 and 3 show two of the intersections also in perspective, more exactly the front, upper and lower intersection respectively and the rear, upper and lower intersection respectively.

Fig. 4 shows a rear intersection in perspective.

30 Fig. 5 shows a triangular connecting element in perspective.

Fig. 6 shows a side view of a modified tool holder according to the invention.

- Fig. 7 shows a frame element for the tool holder shown in side view in fig. 6.  
Fig. 8 shows the tool holder according to Fig. 1 in a loaded state.  
Fig. 9 shows an unloaded tool holder according to a modified embodiment.  
Fig. 10 shows the tool holder according to Fig. 9 in a loaded state.

### **Description of an embodiment**

The tool holder according to the invention consists of an outer C-shaped frame 11, which in turn includes six frame beams 12 - 17, of which beams 12, 13 and 17, 16 form the shanks of the C and the beams 14 and 15 the intermediate part between the shanks. Beams 12 - 17 are interconnected end-to-end via intersections 18 - 22, so that they together form a C.

Inside the outer C-shaped frame 11, is provided a second C-shaped inner frame 23, comprising the frame beams 24 and 25, which also form the shanks of the inner frame 23, while its intermediate part between the shanks consists of beam part 26.

The outer and the inner C-frame 11, 23 are interconnected partly via slewing brackets 27 to 32 and at the end of the shanks via unit attachments 33 and 34. The intersections 18 - 22 are designed with connecting ears 35 having a through bore 36 for shaft journal, which form articulated joints 37 for the slewing brackets 27-32. In the same way the inner connections between the slewing brackets and the inner frame 23 are designed as joints 37. The beam part 26 and the slewing brackets 29, 30 are designed as a fixed triangular construction part 38, at which is provided a holder attachment 39 e.g. for a robot arm (not shown).

The intersections 18 - 22 and the unit attachments 33, 34 are designed with guide flanges 40 and thrust areas 41 for guidance of and pressure transfer to the end part and end areas 42 respectively of frame beams 12-17. By angularly adjustment the thrust areas 41 of the intersections, the ends of the frame beams can be cut perpendicularly, which simplifies manufacturing.

The torsional rigidity in the C-shaped frame is suitably obtained by the attachment of stiffening plates 43 at both its flat sides, which suitably are connected to the frame beams 12-17 and 24, 25 during load subjected to the frame. The connection can be a glue joint, riveted joint or screw

joint or the like. The material can be steel, aluminium, fibre reinforced plastic plates or equal.

In early construction work it proved itself that a frame work construction with intersections free from moments for weight reasons was preferred above a construction having moment absorbing intersections. Solutions comprising moment supporting intersections must be made relatively heavy and unwieldy to be able to handle the heavy loads. The key to achieving a light and durable construction showed to be designing the geometry of the frame work thus that all incoming bars to an intersection meet at one common point. The selected geometry resulted in that the C-frame 11 is put together by a number of interconnected triangles, where at least one side of a triangle is shared with the adjacent triangle.

Since the specific stiffness for composite materials exceeds the one for steel, is it desirable to use as high ratio of composite material as possible to minimize the weight for the selected stiffness. The chosen construction principle with essentially moment-free intersections results in that the outer frame 11 only arises one-axis loads, i.e., compressing strains, whereby composite material is specially suitable for this. As composite material can be used different kinds of reinforced plastic e.g., carbon fibre reinforced plastic, having a specific coefficient of elasticity of about 95 in longitudinal direction compared to about 25 for steel, which means that the carbon fibre frame is almost four times lighter than the corresponding steel frame. Since also combined loads arise in the inner parts of the outer frame and steel is a more cost effective construction material, these parts may suitably be of steel or a combination of steel and carbon fibre reinforced plastic, which in the described embodiment has been selected for the frame beams 24 and 25, where the inner part of the frame beam is a carbon fibre beam 44 and the outer parts are steel rods. The weight of the whole tool holder are about half the weight of a steel frame having a corresponding performance.

However, this does not exclude, that selected parts of the construction can be replaced of composite material, in case the requirements of lowering the weight and/or stiffness and strength are further increased even more.

In order to optimize the properties of the material the fibres are oriented in the extension of the

beams, i.e., longitudinally, which means that the beams can be sawed from carbon reinforced plastic plates and be cut into suitable lengths, whereby the costs for the most expensive parts in the construction can be kept low. The selected construction principle does not require special moulding tools, but permits shell-moulding and modification without large initial costs.

5

The modified embodiment shown in Figs. 6 and 7 differs from the above described in that several joints have been replaced by fixed intersections, but with the maintained requirement, that all connection points are moment-free. By this design it is possible to fixedly connect the slewing brackets 27, 28, 31 and 32 to the frame element 38, as to obtain the appearance shown in Fig. 7.

10 The intersections 18-22 are fixedly integrated to the slewing brackets as to reduce the number of associated parts. The frame element 38 is suitably made of metal, for example of steel. The inner frame beams 24 and 25 are in the same way as before articulately connected to the frame element 38.

15 A disadvantage of designing all intersection points free of moments, is that the tool holder is so deformed during a load, see Fig. 8, that the connection surfaces of the unit attachments 33, 34 not remain parallel but will form an angle  $\alpha$  with the horizontal plane.

When high requirements are put on the accuracy in the working process, i. e., that both parts of  
20 the tool unit 45, which can be a riveting unit 45a and a riveting knob 45b, are essentially in alignment during the riveting operation, or in other words that the connection surfaces of the unit attachments 33, 34 essentially remain parallel, the principle with the moment free intersections or joints can not be established. To be able to control the deformations of the C-shaped tool holder at load, it is suitable that moment is applied into one or more intersections or bars, which  
25 is achieved by that the centre line 46 of the incoming rods to an intersection do not meet in a common intersection point. Therefore all intersections will not be moment free.

In Fig. 9 it is shown how to control the deformation, to achieve certain requirements, e.g., the above mentioned parallelism. In the unit attachment 33 the intersection point 47 of the centre line  
30 46 has been moved outside the attachment 33, as to induce a moment using the moment arm 49 when for instance a riveting load, as shown by arrows 50, attacks the unit attachments 33 and 34.

Further has moment been applied into the intersections 20 and 21, by displacing the attachment points 48, 51 of the frame beams 14, 15, 16 corresponding to the length of the moment arms 52 and 53. Thereby the frame beams 16, 25 and 13, 24 are deformed axially and through bending. Fig 10 gives an example of this, whereby the parallelism of the connection surfaces of the unit  
5 attachments 33, 34 can be maintained.

In this embodiment the stiffening plates 43 are omitted.

The invention is not limited to the embodiment described and shown, but a number of variations  
10 are possible within the scope of the claims. Thus, the holder may consist of a larger or smaller number of triangular sections and different constructions of intersection joints are possible.



**List of reference numerals**

10	tool holder
11	outer C-frame
5 12-17	outer frame beams
18-22	intersections
23	inner C-frame
24,25	inner frame beams
26	beam part
10 27-32	slewing brackets
33,34	unit attachments
35	connecting ears
36	bores
37	joint/ shaft journals
15 38	frame element
39	holder attachments
40	guide flanges
41	thrusts areas
42	end areas
20 43	stiffening plate
44	carbon fibre beam
45	tool unit
45a	riveting unit
45b	riveting knob
25 46	centerline
47	1 <sup>st</sup> intersectional point
48	2 <sup>nd</sup> intersectional point
49	moment arm
50	force arrows
30 51	3 <sup>rd</sup> intersectional point
52,53	moment arm

## Claims

1. Device at tool holder (10) of the kind comprising a substantially C-shaped frame preferably having a long inner range, which frame at its free shank ends carries said tool, for instance a riveting, an glueing or a welding unit,  
5 *characterised in,*  
that the holder (10) comprises a truss or frame work, which includes an outer and an inner C-shaped frame (11, 23) and a number of slewing brackets (27-32) interconnecting these,  
10 that the frames (11, 23) and the slewing brackets (27-32) are arranged to form a number of connected triangular sections, the connection points (18-22, 37) of which are designed as intersections or joints, and  
that the outer C-shaped frame (11) is arranged only to support thrust forces and the inner frame (23) thrust and tensile forces and the slewing brackets (27-32) substantially  
15 tensile forces.
2. Device according to claim 1,  
*characterised in,*  
that the connection points (18-22, 37) are formed as moment free intersections or joints.  
20
3. Device according to claim 1 and 2,  
*characterised in,*  
that a stiffening plate (43) is attached to the holder (10), on at least one flat side, preferably on both flat sides.  
25
4. Device according to claim 1,  
*characterised in,*  
that the outer C-shaped frame (11) is made of a composite material having a high coefficient of elasticity, preferably carbon fibre reinforced plastic.  
30

5. Device according to claim 1,  
*characterised in,*  
that the outer C-shaped frame (11) consists of a number of rod shaped frame beams (12-17) connected to each other via said intersections (18-22), which are designed to guide  
5 the ends of the beams laterally.
6. Device according to claim 1,  
*characterised in,*  
that the shanks (24, 25) of the inner C-shaped frame (23) are combined of at least one  
10 beam of composite material and at least one reinforcement preferably of steel.
7. Device according to claim 1,  
*characterised in,*  
that the intermediate part (26) between the shanks of the inner C-shaped frame (23)  
15 consists of a triangular frame element (38), in which an attachment (39) is arranged for carrying the holder (10).
8. Device according to claim 1,  
*characterised in,*  
20 that at least some of the intersections (18-22) of the holder (10) are designed as moment-free, one-axis joints.
9. Device according to claim 1,  
*characterised in,*  
25 that each of the free ends of the outer and the inner shank (11, 23) are interconnected by means of a unit attachment (33, 34).

10. Device according to claim 1,  
*characterised in,*  
that the triangular frame element (38) is designed with fixedly connected slewing  
brackets (27, 28, 31, 32), which at their free ends are provided with fixed intersections  
5 (18-22).
11. Device according to claim 1,  
*characterised in,*  
that at load moments are induced in one or more intersections and /or bars, that the  
10 centre lines (46) through one or more frame beams and /or one or more slewing brackets  
in an intersection are arranged not to meet in a common intersection point.

1/7

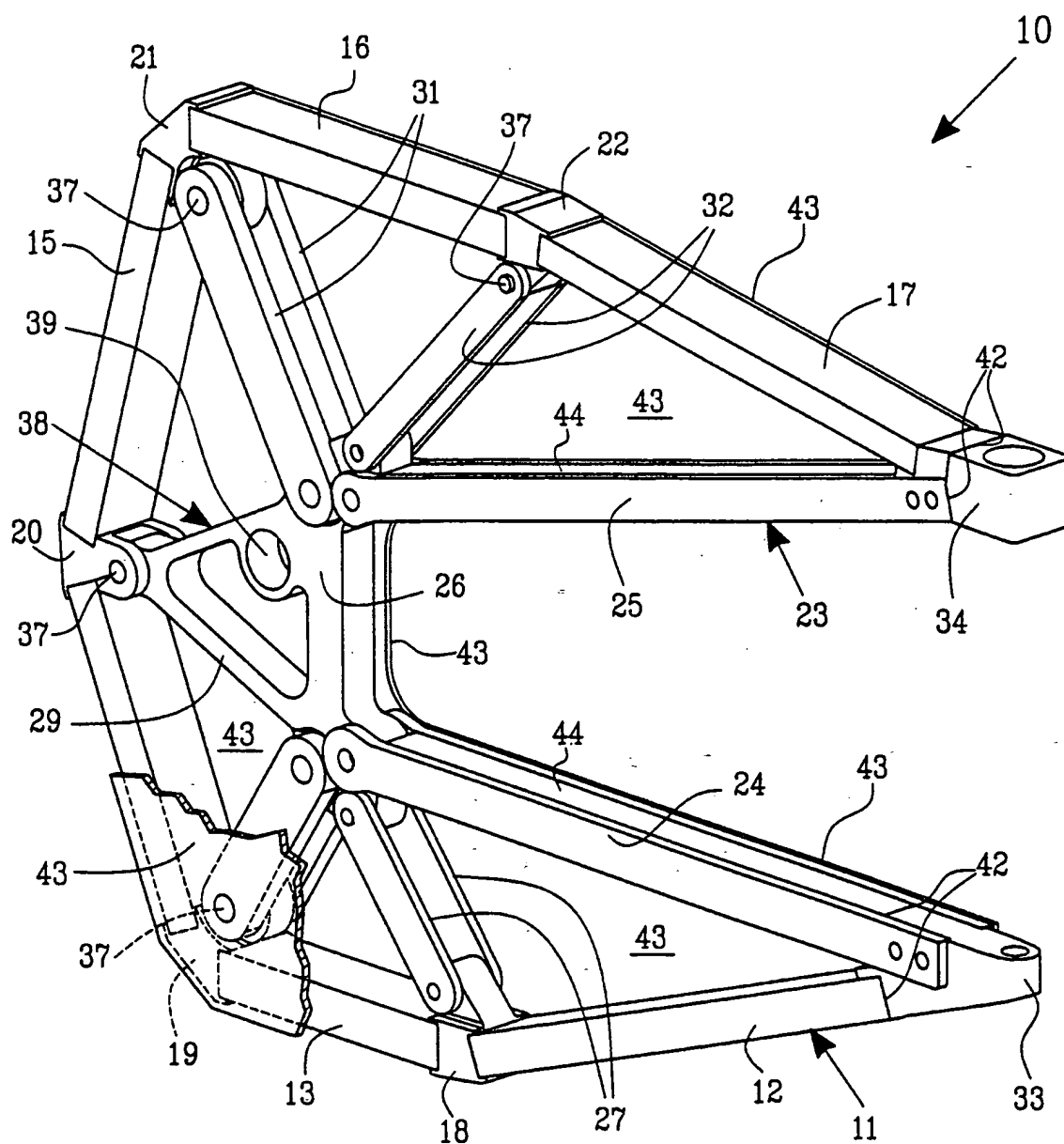


FIG. 1

2/7

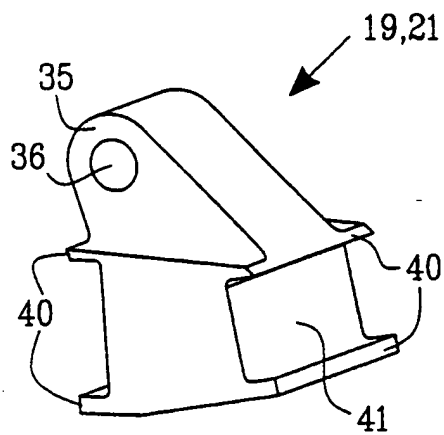


FIG. 2

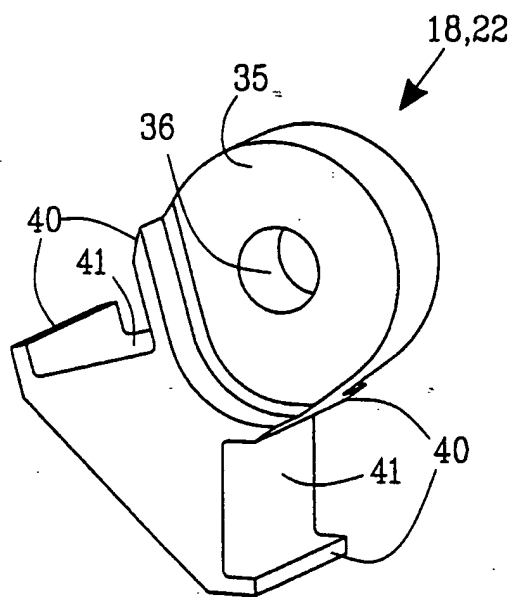


FIG. 3

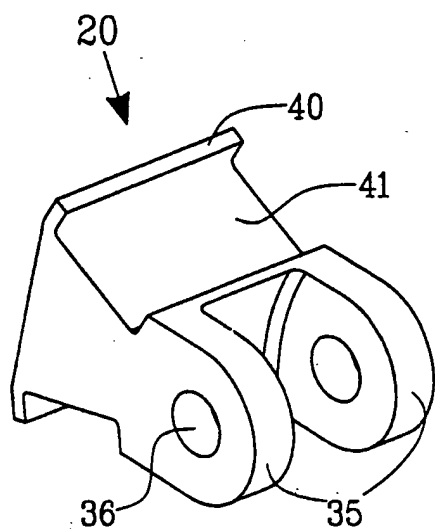


FIG. 4

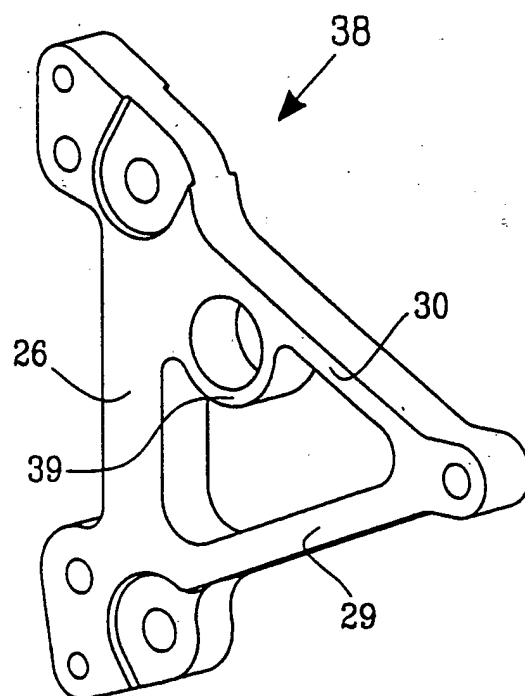


FIG. 5

3/7

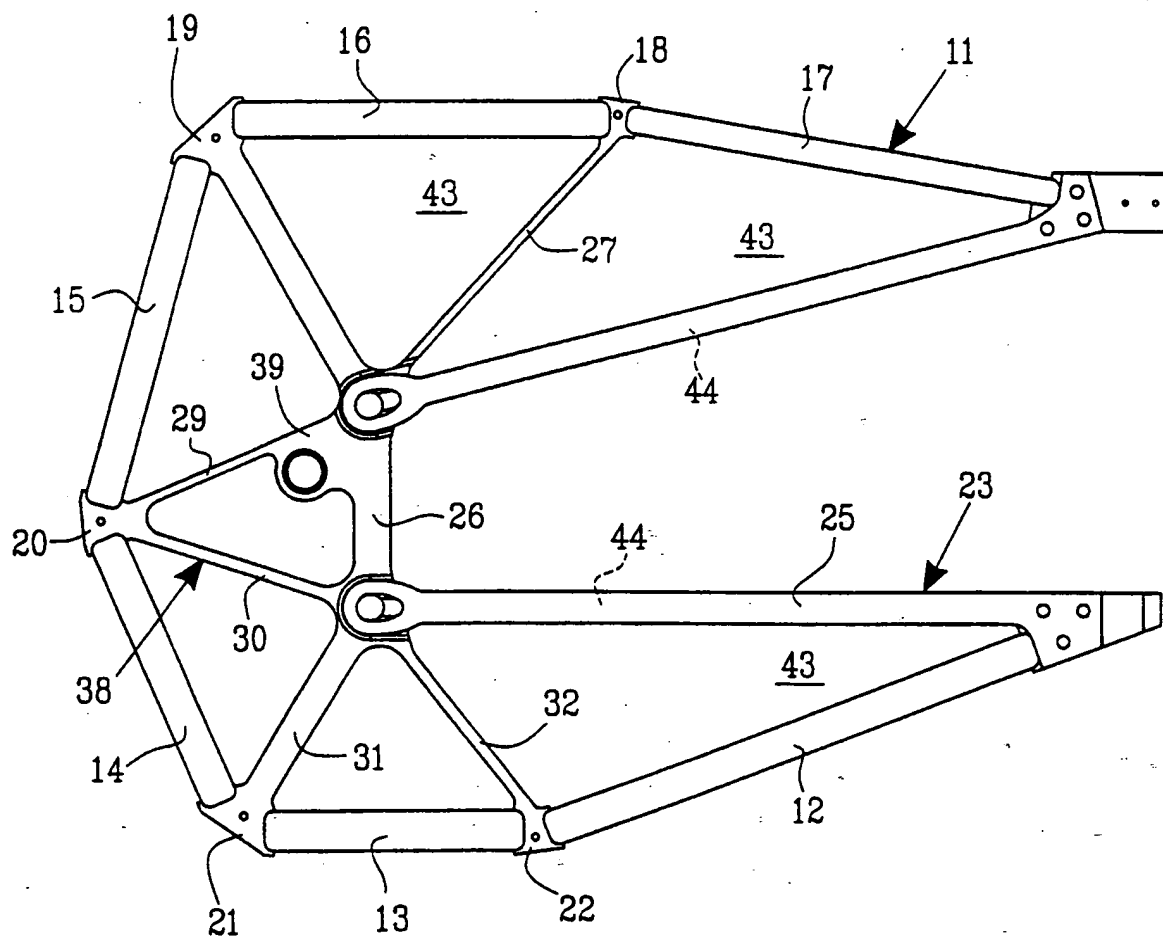


FIG. 6

4/7

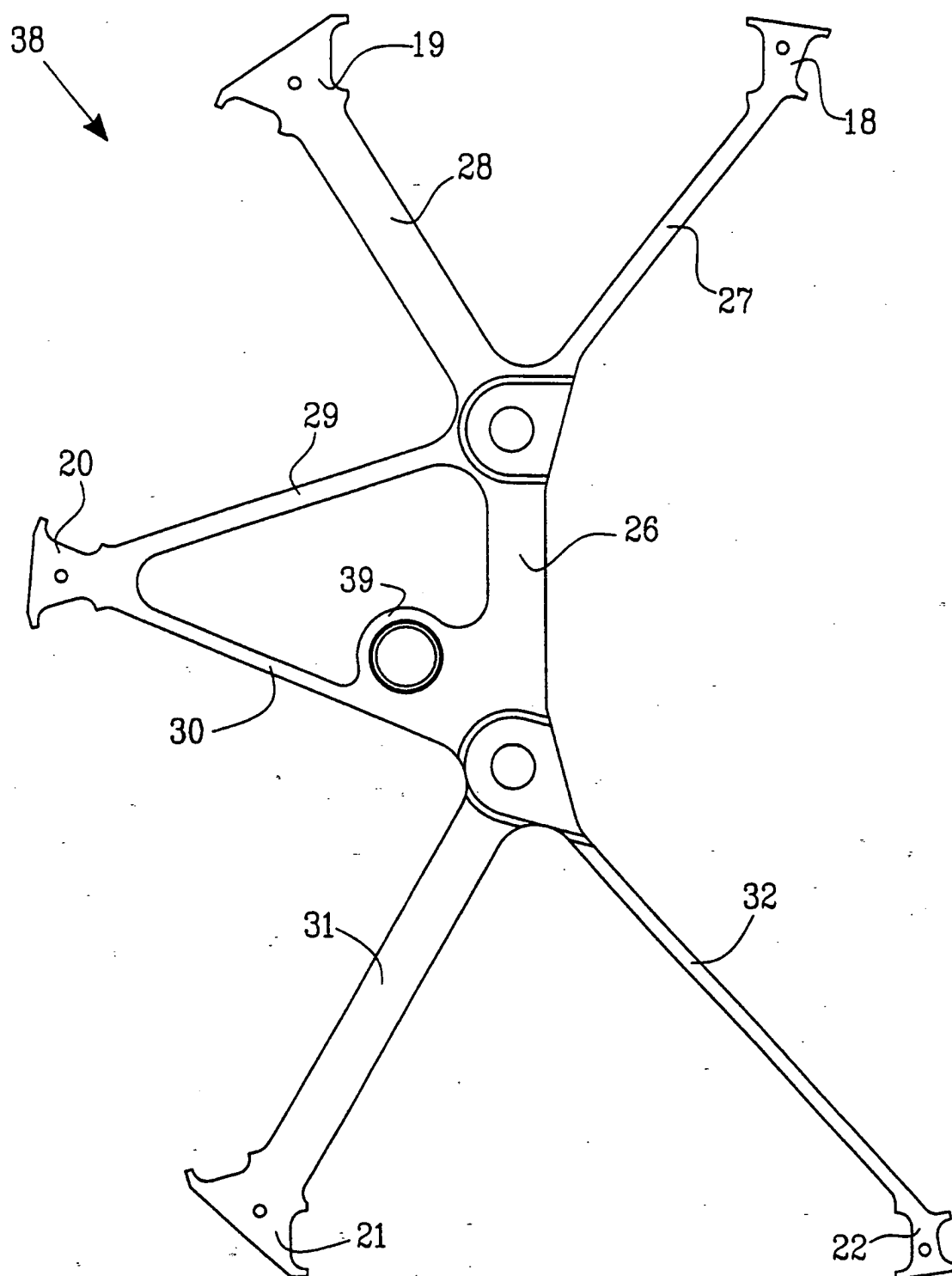


FIG.7



5/7

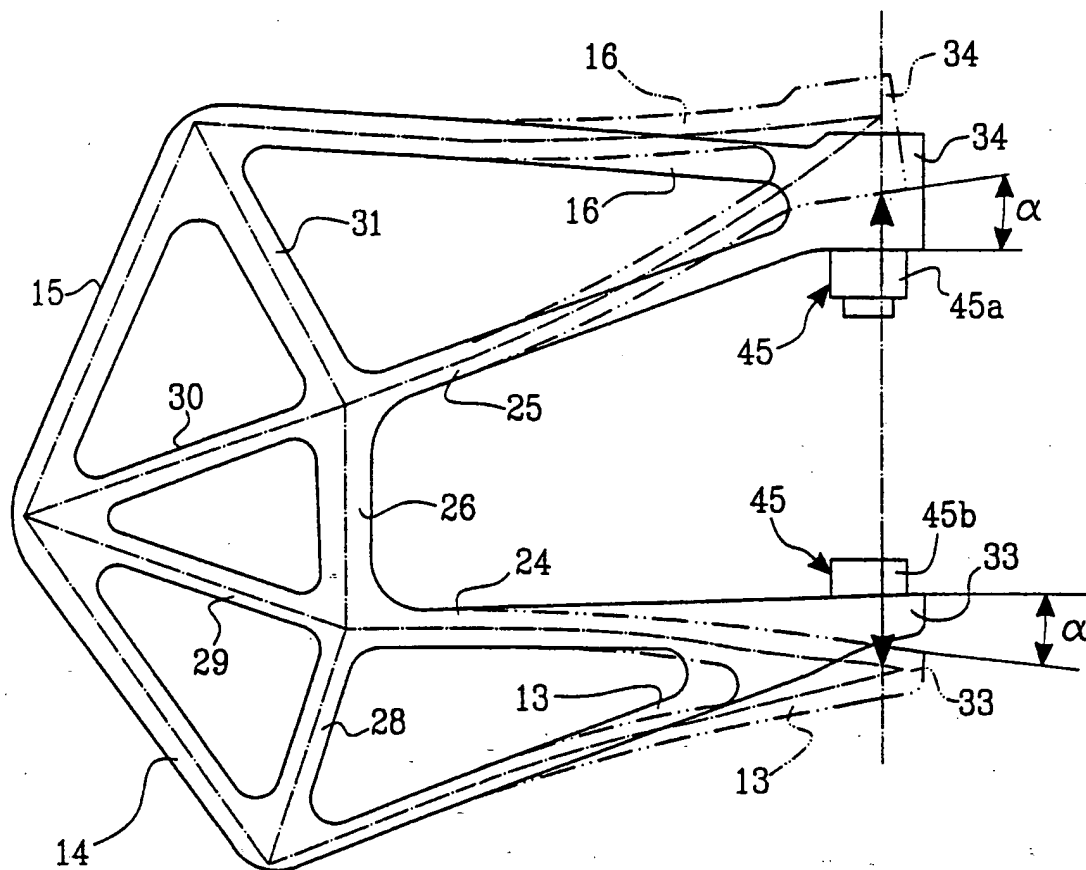


FIG. 8

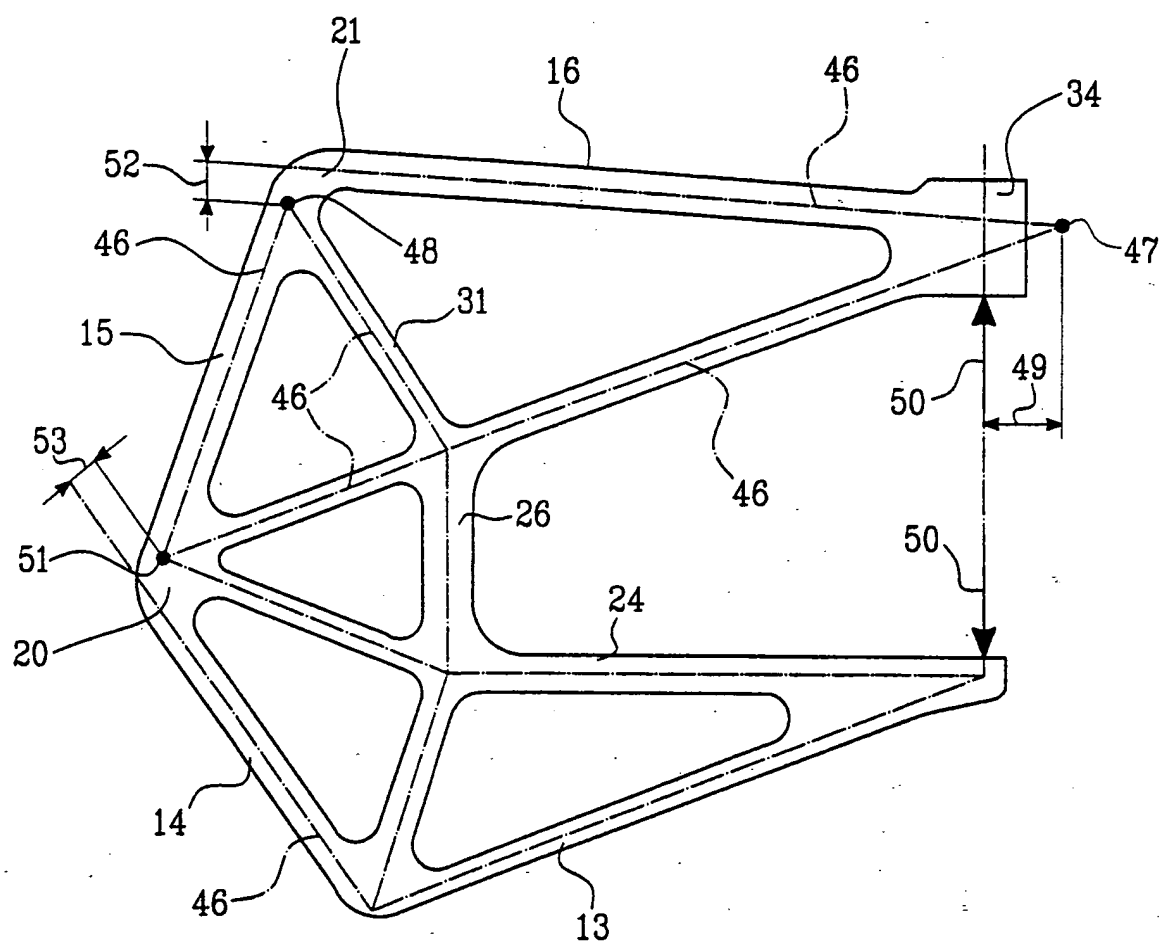


FIG. 9



# 1

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE 99/01106

### A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B23Q 1/25

According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B23Q, B25J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC, WPI, JAPIO

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9006831 A1 (NATIONAL RESEARCH DEVELOPMENT CORPORATION), 28 June 1990 (28.06.90), figures 5-12, abstract --	1-11
A	DE 3320874 A1 (CHIRON-WERKE GMBH), 13 December 1984 (13.12.84), figures 1-2, abstract --	1-11
A	EP 0291828 A2 (CHIRON-WERKE GMBH & CO. KG), 23 November 1988 (23.11.88), figure 1, abstract -- -----	1-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
---	--

Date of the actual completion of the international search

7 Sept 1999

Date of mailing of the international search report

16-10-1999

Name and mailing address of the ISA:

Swedish Patent Office  
Box 5055, S-102 42 STOCKHOLM  
Facsimile No. +46 8 666 02 86

Authorized officer

Olivier Piolat/CF  
Telephone No. +46 8 782 25 00

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/SE 99/01106**

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
WO	9006831	A1	28/06/90	EP	0449926 A	09/10/91
				JP	4502430 T	07/05/92
				RU	2051778 C	10/01/96
				US	5473852 A	12/12/95
-----						
DE	3320874	A1	13/12/84	NONE		
-----						
EP	0291828	A2	23/11/88	DE	3717201 A,C	08/12/88
				DE	3873819 A	24/09/92
				JP	1289634 A	21/11/89
				JP	2005806 C	11/01/96
				JP	7025004 B	22/03/95
				US	4879802 A	14/11/89
-----						

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☒ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☒ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**